

Monitoring Methods Used to Improve Agricultural Conservation Practice Evaluations at the Edge-of-Field Scale

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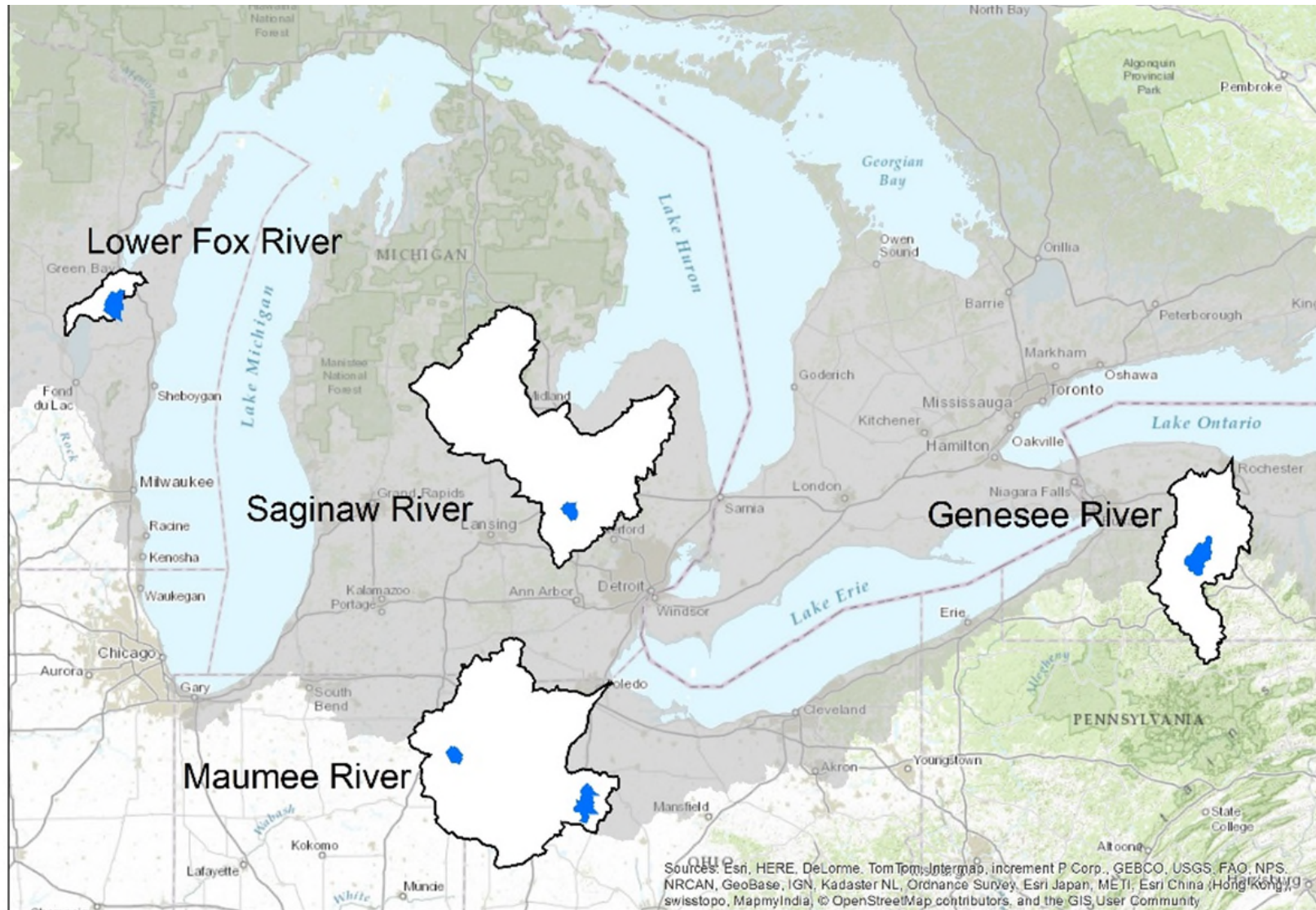


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Executive Summary

- Phosphorus reduction in the Great Lakes is the current focus to reduce nearshore lake eutrophication and harmful algal blooms
- Multi-agency partnerships formed during GLRI to evaluate successes of voluntary, producer-based efforts
- Tiered monitoring and modeling is necessary to address complex processes at various scales
- Incorporation of monitoring efforts into the conservation programs and producer discussion are essential for the adaptive management of the conservation systems

Priority Watersheds



Priority Watersheds



Lower Fox River, Wisconsin
(East River)



Saginaw River, Michigan
(Alger Creek)



Genesee River, New York



Saginaw River, Michigan
(Threemile Creek)



Maumee River, Indiana
(Black Creek)



Maumee River, Ohio
(Eagle Creek)



Monitoring Scale – Streams to Field Edge



Prepared in cooperation with the Wisconsin Department of Natural Resources

Effects of Best-Management Practices in Bower Creek in the East River Priority Watershed, Wisconsin, 1991–2009



Scientific Investigations Report

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
U.S. Geological Survey



Evaluating Barnyard Best Management Practices in Wisconsin using Upstream-Downstream Monitoring

by Todd D. Stantewick

Introduction

The Nonpoint Source Water Pollution Abatement Program was created in 1973 by the Wisconsin Legislature. The goal of the program is to improve and protect the water quality of lakes, streams, wetlands, and ground water within selected priority watersheds by controlling sources of nonpoint pollution. For each selected watershed, the Wisconsin Department of Natural Resources drafts a management plan that guides the implementation of pollution-control strategies known as Best Management Practices (BMPs). This plan estimates the amount and land-use intensification, describes the results of pollution-source modeling, and suggests pollution-reduction goals. The U.S. Geological Survey, through a cooperative effort with the Wisconsin Department of Natural Resources, is monitoring water-quality improvements that result from the implementation of BMPs. The data collected are then compared to the watershed plan to assess progress and determine whether goals are being realized. This fact sheet describes the data-collection efforts, preliminary results, and planned data-analysis techniques of monitoring projects for pre-BMP conditions at two barnyards, one each in Otter Creek and Halfway Prairie Creek.

Data Collection

Two sampling stations were established at each stream (fig. 1). One station is upstream from a single barnyard-ranch feature, and the other station is downstream from

that same source. The barnyards investigated were identified by each watershed plan as critical nonpoint sources based on land use, lot size, proximity to the stream, and down-slope overland flow characteristics.

Otter Creek is within the Sheboygan River Priority Watershed, 15 miles west of Lake Michigan, in east-central Wisconsin (fig. 1). The drainage area of Otter Creek is 9.2 square miles at the downstream sampling station, and land use in the watershed is 67 percent agricultural (Blackburn and Poye, 1993). Upstream and downstream sampling stations, each of which are equipped to continuously monitor streamwater levels and collect discrete water samples,

were installed at Otter Creek in March 1994. Water samples are collected with a refrigerated water-quality sampler that is activated by the rise and fall of streamwater levels.

Halfway Prairie Creek is within the Black Earth Creek Priority Watershed, 20 miles northwest of Madison, in south-central Wisconsin (fig. 1). The drainage area of Halfway Prairie Creek is 14.3 square miles at the downstream sampling station, and land use in the watershed is 100 percent agricultural (Boggs and Merten, 1999). Upstream and downstream sampling stations were installed at Halfway Prairie Creek in April 1993. The upstream sampling station continuously monitors streamwater levels and precipitation and collects discrete water samples with a refrigerated water-quality sampler. The downstream station is equipped to collect water samples only.

Upstream-downstream sampling schemes have the inherent potential for upstream loading sources to mask the effects of the investigated source, because individual inputs are often small compared to the cumulative inputs from upstream (Spanner and others, 1985). To reduce the potential for this problem, project investigators modeled two enhancements to the sampling design used at Otter Creek in order to improve the isolation of

EXPLANATION
▲ Sampling station



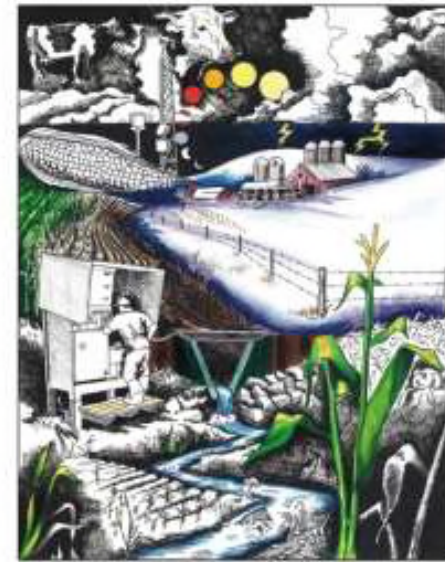
Figure 1. Location of upstream and downstream sampling stations for Otter Creek (above) and Halfway Prairie Creek (below).

EXPLANATION
▲ Sampling station



Prepared in cooperation with the University of Wisconsin–Madison Discovery Farms program, the University of Wisconsin–Platteville Pioneer Farm program, the Wisconsin Department of Natural Resources, and the Sand County Foundation

Precipitation-Runoff Relations and Water-Quality Characteristics at Edge-of-Field Stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003–08



Scientific Investigations Report 2011–5008

U.S. Department of the Interior
U.S. Geological Survey



What is EOF Monitoring?

- Small Ag basins
- Concentrated flow
- Year-round - natural rainfall/snowmelt
- Surface and/or Tile



Why do EOF Monitoring?

- Better understanding of sources
- Effects of practices, field activities
- Improved models
- Shorter study duration
- Producer involvement



USGS EOF Monitoring History

- Projects since 2001:
 - Pioneer Farm (2001 – 2011) 13 Sites
 - Discovery Farms (2003 – ongoing) 36 Sites
 - Currently 11 EOF
 - Mississippi River Basin Initiative (2012 – 2014) 3 Sites
 - 2 EOF, 1 Tile
 - W. Branch Milwaukee River (2012 – 2015) 3 Sites
 - GLRI (2012 – ongoing) 22 Sites
 - Currently 14 EOF, 8 Tile
- 60+ EOF Surface Water Sites
 - > 250 site-years of record
- 16 Subsurface Tile Sites
 - > 50 site-years of record



Not Your “Traditional” Sites



- Depending on site conditions, limited number of events
- Directly impacted by field treatments
- Variable concentrations during events

- Each site is custom to fit location and study objectives
- Need to minimize disturbance to agricultural activities
- **Need Flexibility**



Equipment



Measure the quantity and quality of water leaving agricultural sites (edges-of-fields, streams and tiles)

Typical Monitoring Station



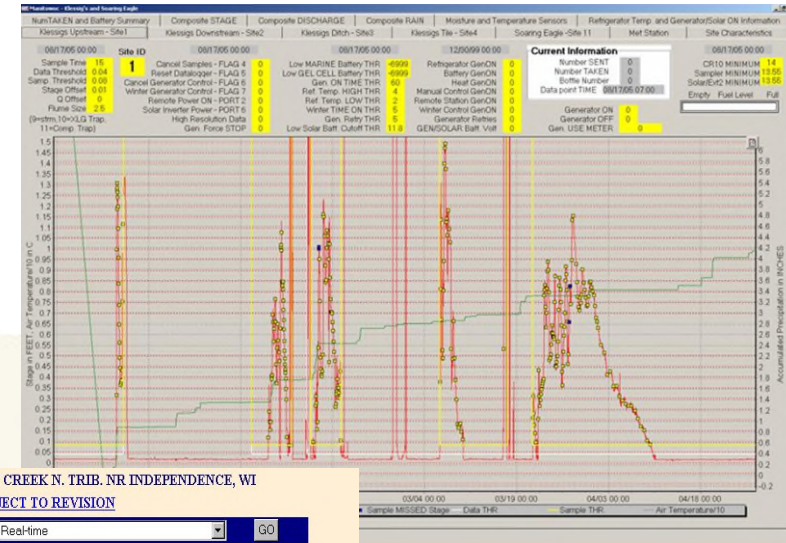
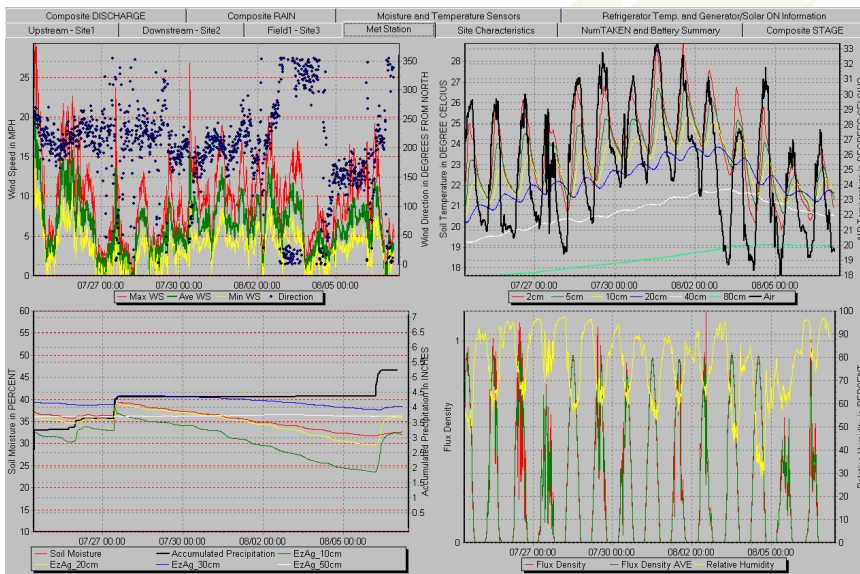
- Datalogger
 - Stage sensor
 - Refrigerated Autosampler
 - Power Source(s)
 - Communication
 - Time-lapse camera
-
- ~\$20-\$25K per station depending on power needs

Challenges



Turning Data into Information

- Collecting the data is only one step



USGS 053793305 TRAVERSE VALLEY CREEK N. TRIB. NR INDEPENDENCE, WI

[PROVISIONAL DATA SUBJECT TO REVISION](#)

Available data for this site

[Latest picture at site](#)

Station operated in cooperation with the Wisconsin Department of Natural Resources and the University of Wisconsin - Madison.

This station managed by the Wisconsin District Office - Middleton, WI.

Available Parameters

All 8 parameters available at this site

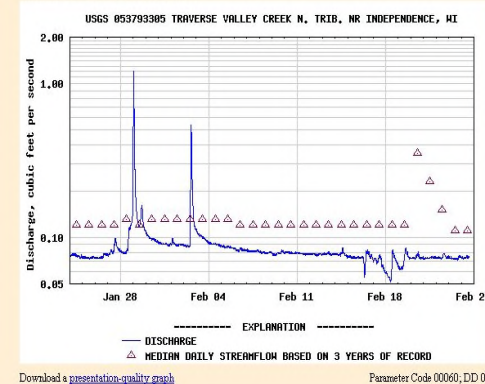
Output format

Days

(1-31)

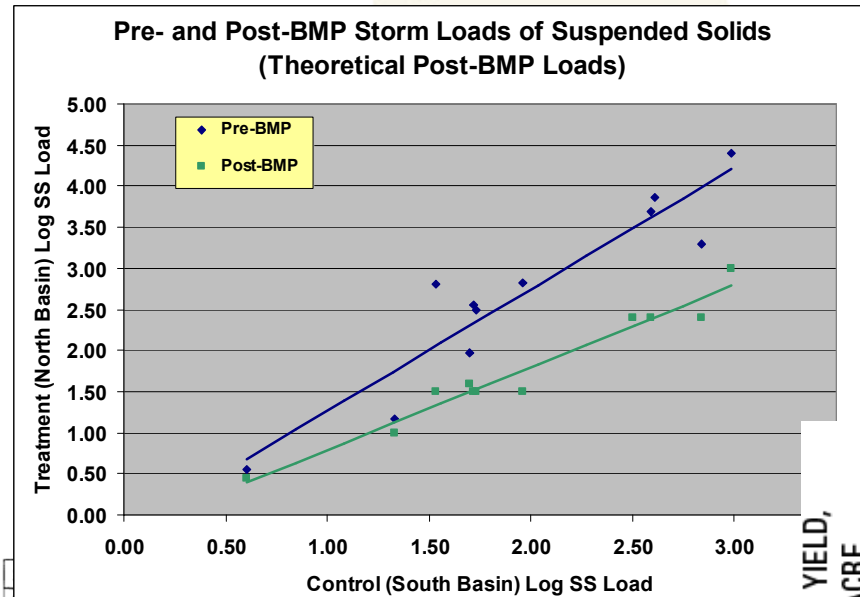
Discharge, cubic feet per second

Most recent value: 0.075 02-24-2006 15:00

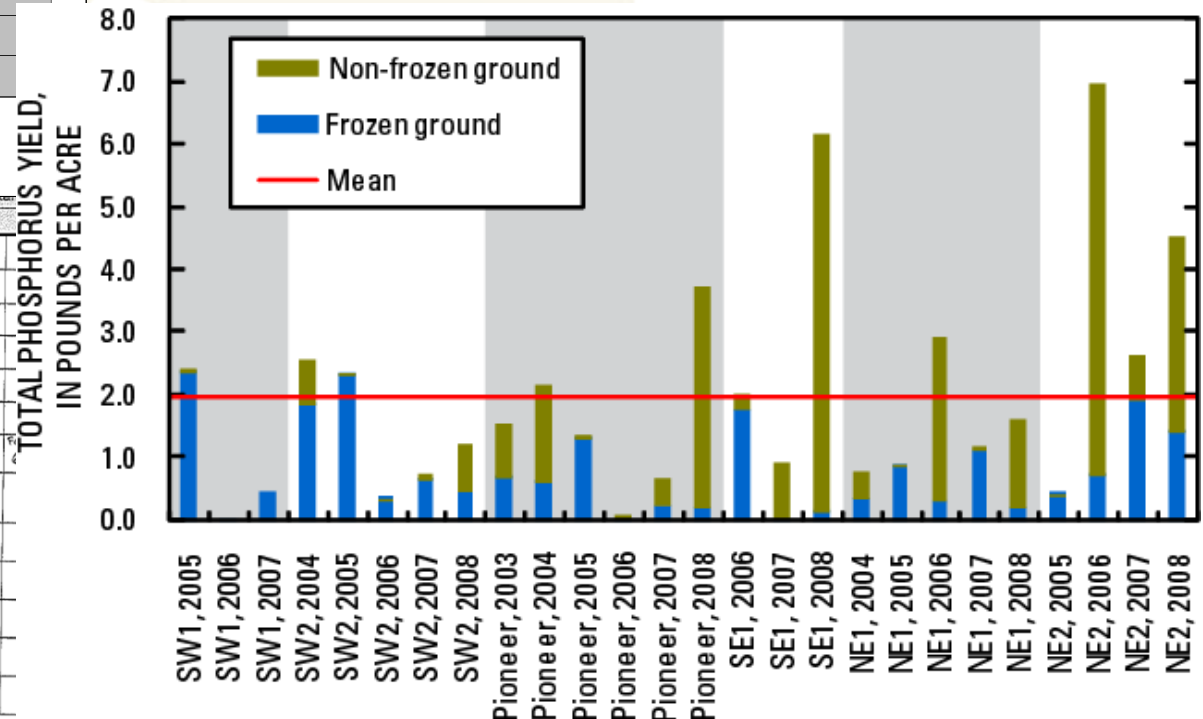


Turning Data into Information

- Evaluation of a BMP
- Defining the impact of agricultural practices
- Calibration/validation data for models



Crop Year: 2012	3	11.3			
Use more than one column for each operation type in a crop year if needed	1st	2nd	3rd	4th	5th
Crop and Planting Date	2011 May				corn 5-7-12
Primary Tillage (SP, FC, SC, NT) and Date	FC 10-25-11				
Secondary Tillage and Date		FC 5-1-12	FC 5-12	FC 5-6-12	
Other Tillage and Date		X			
Residue Removal		NA			
Cultivation (specify timing and method below)		FC 5-1-12			
Applied Manure: Type: Solid/Semi/Liquid Rate: /ac and Date (see attached Map)		X			
Manure Incorporation and Date		X			
Commercial Fertilizer Type Rate: /ac and Date		potash 5-14-12 280 lb 5-4-12			9-23-30 100 lb/ac 5-7-12
Commercial Fertilizer Placement/Incorporation and Date		broadcast			bander
Soil Amendments (e.g., Lime, etc.) Rate: /ac and Date		X			
Soil Amendments Placement/Incorporation and Date		X			
Notes (e.g., Soil Test Data, Residue % Cover Following Harvest)					Roundup 1st 5-9-12



Meeting Needs



```
> #MINIMUM DETECTABLE CHANGE calculation without implementation data:
> model = lm(SW5_TP ~ SW4_TP, data=CalData)
> summary(model)
```

```
Call:
lm(formula = SW5_TP ~ SW4_TP, data = CalData)
```

```
Residuals:
    Min       1Q   Median       3Q      Max
-0.097262 -0.046951 -0.004939  0.037845  0.165306
```

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.03397    0.02792   1.217   0.255
SW4_TP       1.28160
---
Signif. codes:  0 ' ' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 0.107
Multiple R-squared:  0.00927
F-statistic: 350.8
```

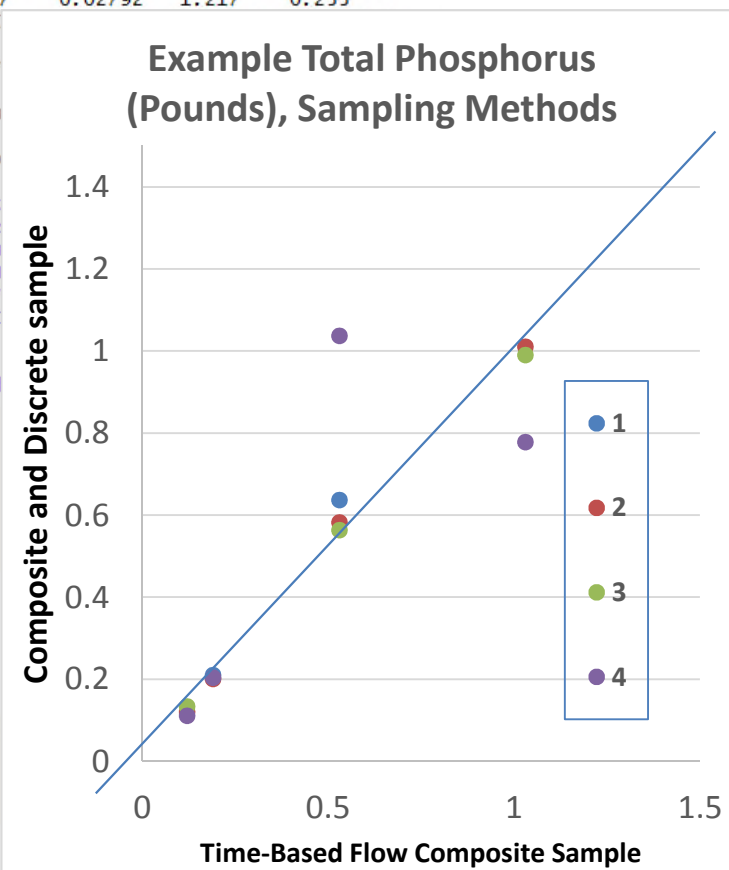
```
> N <- 11 #sample size
> MSE <- 0.06843 #residual mean square
> #student's t-distribution
> T <- -1.833 #for 95% confidence
> mdc <- T*(sqrt(MSE))
> mdcPercent <- (1 - mdc)
> mdcPercent
[1] 48.61309
> #48.6% #this is the minimum detectable change
```

```
TPLoading at
Number of observations: 36
Distribution: lognormal
Method: AMLE
Degrees of freedom: 4
RMSE: 0.7192871
StdErrPercMean: 0.3233073
RSQ: 0.854123
Number of censored values: 0
TPLoading ~ (Intercept) + log(peakDisch) + p60max.inches.per.hour + log(rain_amount)
```

Term	Coefficient	StdError	pvalue	StCoef
1 (Intercept)	2.011	0.301	0.000	6.685
2 log(peakDisch)	1.502	0.115	0.000	13.104
3 p60max.inches.per.hour	-2.428	0.419	0.000	-5.790
4 log(rain_amount)	0.340	0.124	0.006	2.748
5 logsigma	0.517	0.119	0.000	4.358

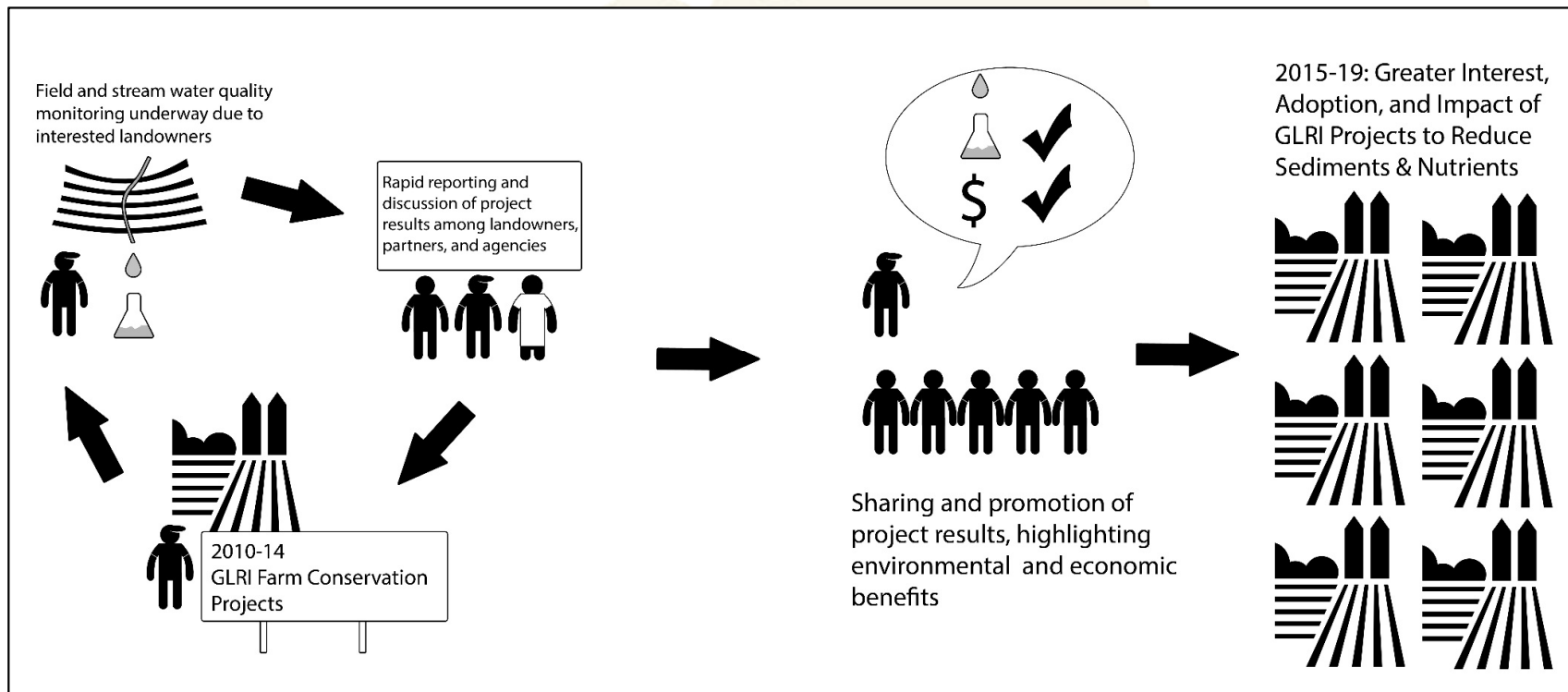
Correlation matrix of coefficients:

	(Intercept)	log(peakDisch)	p60max.inches.per.hour	log(rain_amount)	logsigma
(Intercept)	1.0000	0.5913	-0.8677	0.5112	1e-04
log(peakDisch)	0.5913	1.0000	-0.4310	-0.0423	1e-04
p60max.inches.per.hour	-0.8677	-0.4310	1.0000	-0.5065	-1e-04
log(rain_amount)	0.5112	-0.0423	-0.5065	1.0000	2e-04
logsigma	0.0001	0.0001	-0.0001	0.0002	1e+00

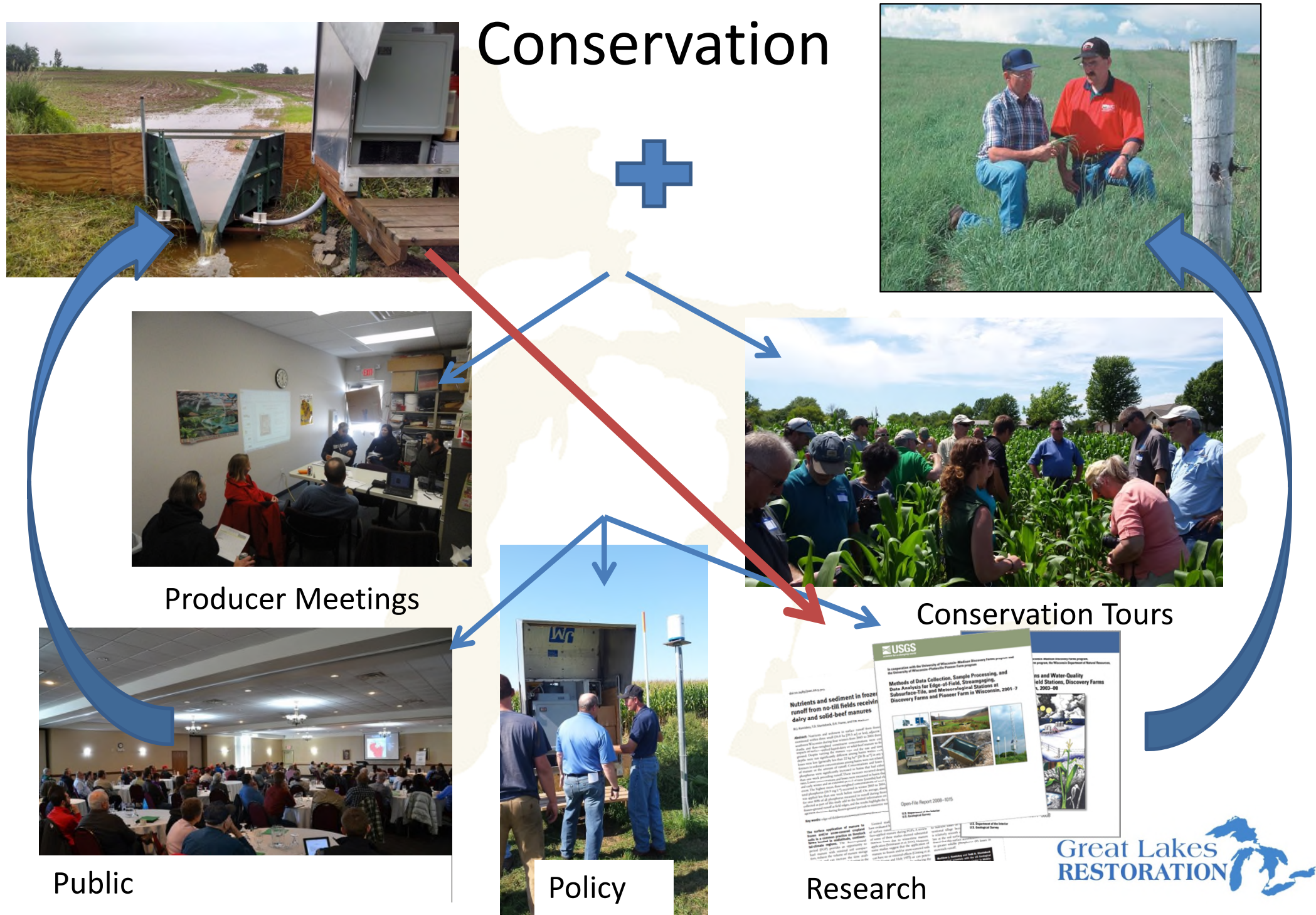


Beyond Change Detection

- Education
- Partnership building
- Producer Involvement
- Model calibration



Advancing Science and Improving Conservation





“People here in the United States – and in many other countries – are learning that we must have soil conservation if we are to have continuous, abundant agricultural production.

We are fast learning, too, that **it must be effective conservation...**”

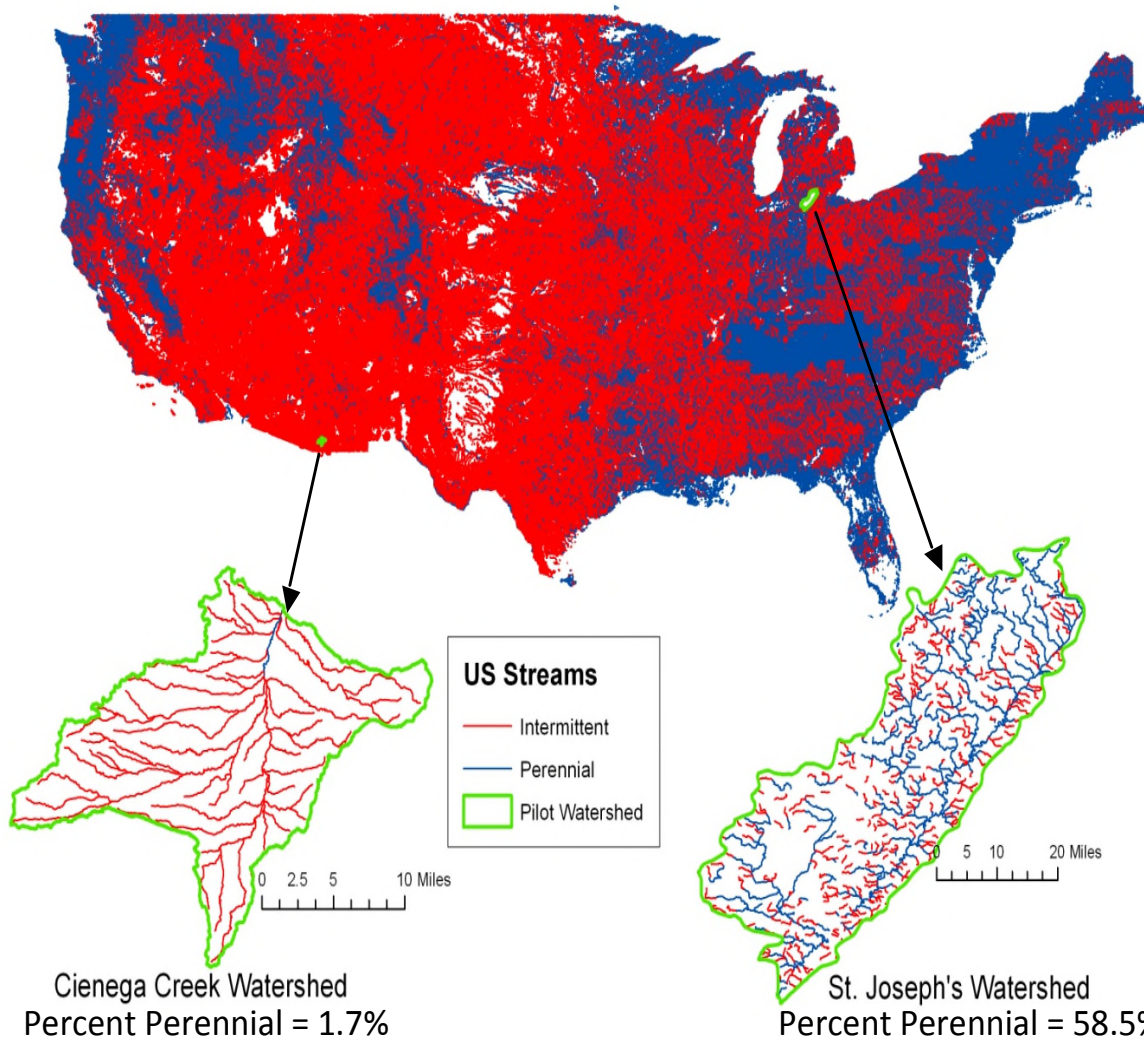
Dr. Hugh H. Bennett, 1946, JSWC 1 (1): 21-24.

Who Needs Data and Why?



Producers, farm managers, advisors

- Feedback on practices, concerns
- Support adaptive management, conservation planning



Cienega Creek Watershed
Percent Perennial = 1.7%

St. Joseph's Watershed
Percent Perennial = 58.5%



Agencies, scientists

Research – understanding
data reporting
accountability
different scales of
reporting expectations
national/ large regional
small watershed with
implementation
value of benchmarks



Water Quality Monitoring Is a Tool

CANNOT

- Conduct watershed planning
- Determine appropriate conservation practices
- Determine critical source areas
- Identify watershed farmers' attitudes toward conservation practices
- Maintain conservation practice
- Provide economic and technical assistance

CAN

- Help Identifying pollutant(s) of concern, sources, and hydrologic transport
- Help identify conservation practice effectiveness
- Inform future management decisions
- Provide information for outreach and adaptive management



Photo by Deanna Osmond, Rock Creek CEAP, 20

How Can NRCS Use EOF Data?

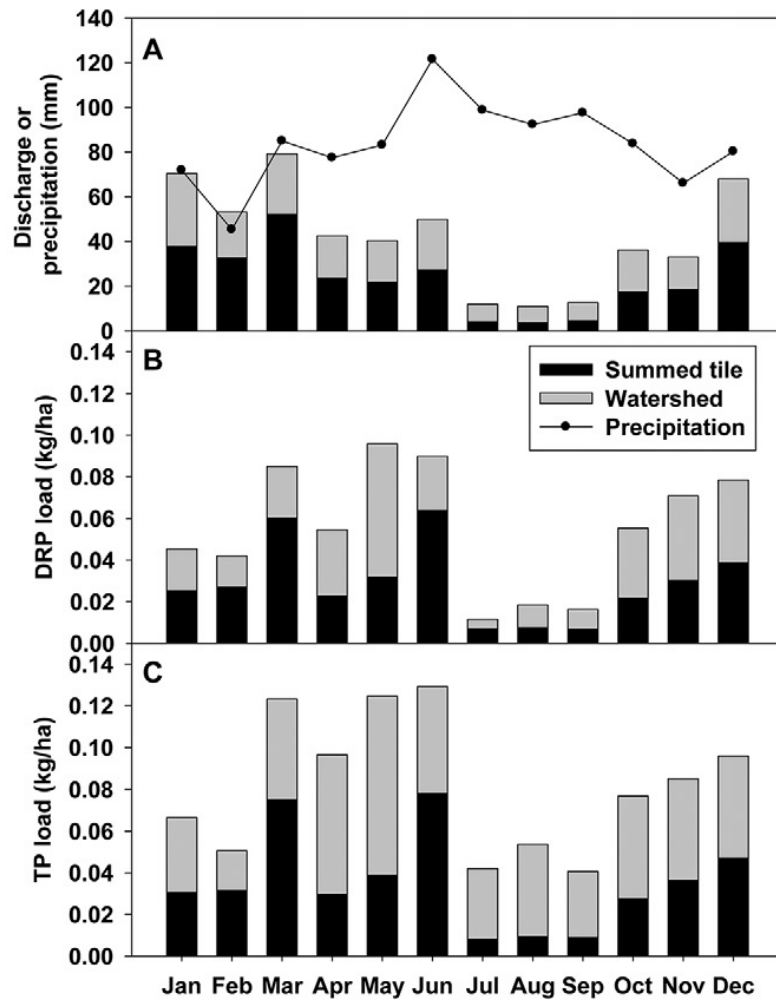
- Conservation Planning
 - Practice effectiveness (need under a range of conditions)
 - Practice interactions and systems, where we can test that, at field scale
- Practice Standards
- Modeling
 - algorithm development
 - need a range of weather, soils, hydrologic conditions
 - calibration, validation



Photo by Lisa Duriancik. EOF monitoring in Indiana.

How Can NRCS Use Watershed Data?

Upper Big Walnut Creek ARS CEAP Watershed, OH



- Primary constituents, sources and flow paths for planning
- Outcome reporting
 - Align with conservation implementation
 - Feedback into watershed conservation plan
- Explanatory variables
 - Why or why not?
 - Be explicit about conclusions
 - Articulate the nuances
 - EOF within helps
- Modeling to help understand and attribute effects
 - Combined approach often necessary



King, Kevin W., et al. 2014. JEQ.

Considerations for Greater Utility of Water Quality Monitoring Data

Comprehensive scales and watershed designs more useful

- EOF, within watershed and at watershed outlet
- Combine locations regionally
- Model to evaluate broader effects

Synthesize lessons learned

- Inform
- Share
- Guide and
- Inform assess approach

**The 3 Cs:
COORDINATE
COLLABORATE
COMMUNICATE**

ated
vation
entation with
ng and
ent at

/partner

ignment?
Include
groundwater where
appropriate and
feasible